

The German „Schülerlabor“ – a SEMT educational innovation

Rolf Hempelmann

Physical Chemistry, Saarland University, Saarbrücken, Germany

Chemistry-Schülerlabor NanoBioLab, Head

Saarland's Schülerlabor Group SaarLab: Spokesman

LernortLabor - Federal Association of Schülerlabors, Berlin: President



definition

$$\text{Schülerlabors} \subset \left\{ \begin{array}{c} \text{out-of-school} \\ \text{SEMT} \\ \text{places to learn} \end{array} \right\} \subset \left\{ \begin{array}{c} \text{out-of-school} \\ \text{places to learn} \end{array} \right\}$$



- enable contact and experience with up-to-date science and/or technology,
- provide well-equipped laboratories,
- allow young people to perform experiments hands-on,
- have a regular periodical offer of practicals.



how to translate „Schülerlabor“



school lab ?	it is not at school!
student´s lab	school students or university students?
extracurricular science lab ?	mostly not extracurricular!
informal science lab ?	mostly formal, sometimes non-formal, in some cases non-formal/informal



types, characteristics and examples of learning

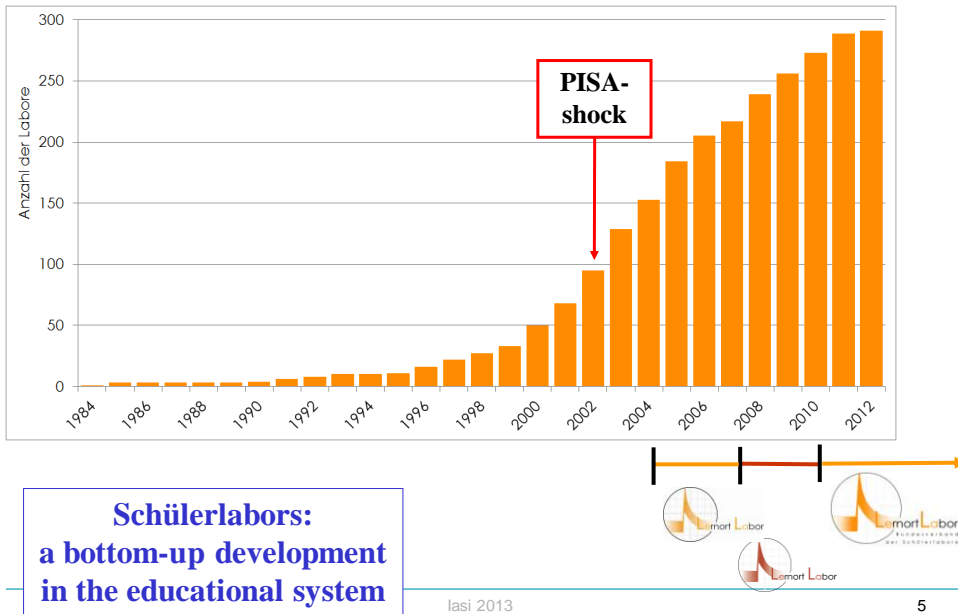


Type	Characteristics			Example
formal	school (attendance)	at school, out-of-school	organised	regular lessons at school, a class visits a museum (organized by the teacher), a class visits the university for a project
non-formal	voluntary	out-of-school and free-choice	organised	summer school, science courses in the students' free time
informal	voluntary		not organised	TV, visiting a zoo on Sunday

Stocklmayer, Rennie & Gilbert 2010



schülerlabor or **schuelerlabor**

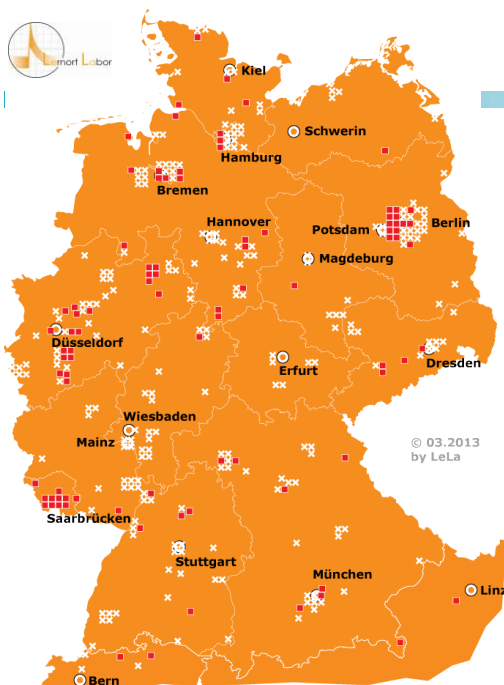


coordination by the community itself



2010: foundation meeting of Federal Association of Schülerlabors:
„LernortLabor – Bundesverband der Schülerlabore e.V.“





Large block of SEMT-offers

scene of schülerlabors seemingly
confusing and heterogeneous

Problem for:

users, education administration,
educational politics,
possible supporters,
educational scientists



- request to LernortLabor:
categorisation / catalogisation
- 2 BMBF-projects

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„state of the art“

Heterogeneity of scene of schülerlabors → diffuse and generalizing statements
not only in the press, but also in papers of educational sciences
(compare, e.g., *Schmidt, Di Fuccia & Ralle 2011; Priemer 2012*).

Previous attempts of classification of schülerlabors:

- *Dähnhardt, Sommer und Euler (2007)*: **owner-oriented approach**
(universities, research centers, science centers and musea, technology & founder
centers, big science-based industry).
- *Pfenning (2013)*: **historically oriented approach**
(Schülerlabors of the 1st, 2nd and 3rd generation, perhaps also 4th generation?).

Disadvantages of previous attempts:

- do not separate the entity of *schülerlabors* from other out-of-school places to learn
and from in-school offers in the field of SEMT,
- only partially indicate the function of the different types of schülerlabors,
- no correlation between name and function of the respective schülerlabor.

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claims and primary aims of *a//*schülerlabors

Our claim: schülerlabors assume essential tasks in Society & National Economy

to arouse the interest in and to support the comprehension of natural and engineering sciences in children and young people → **Scientific Literacy**

Service for our Society: young people of today → adults of tomorrow, they will participate in shaping the future of our **science-based society**.

to motivate for non-academic SEMT professions and for SEMT university studies.

Service for our National Economy → measure against the shortage in personal interested in science and engineering, **technology-based economy**.



Schülerlabors as out-of-school places to learn actively support the schools:

school problem: shortage in equipment and in time for laboratory work;

general school problems: **Heterogeneity** and **Inclusion**

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primary criteria for *a//*schülerlabors



- **out-of-school place to learn in the field of SEMT**
with real address, really out of school
- **scheduled operation at 20 days per year at least**
(schülerlabor operation at least at 10 % of the days available in the year, otherwise spontaneous school-student events)
- **hands-on experiments**
with the research process
in the focus:

- inquiry-based experiments

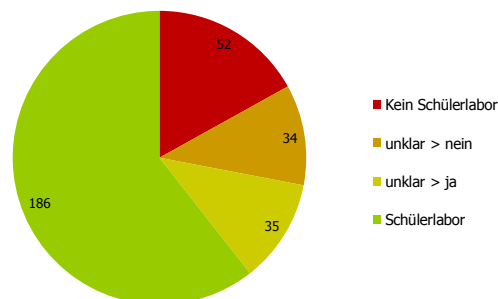
or

- guided inquiry-based experiments,

or

- recipe-type experiments

**out-of-school places to learn
registered at LeLa**



About two thirds of the out-of-school places to learn registered at LeLa are „real“ Schülerlabors.

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originating from the secondary aims of the respective operator

for instance universities:

advertisement for better beginner students,
improvement of the education of teacher students
with respect to practical relevance

for instance large-scale companies:

cultivation of their image,
advertisement for (non-academic) technical jobs

for instance communities:

measure against shortage in technical personal
of the local SMEs;
this is an obstacle for economic prosperity



category	mode	criteria
SchülerLabor ^K	Klassical Schülerlabor	<ul style="list-style-type: none"> • <i>Broad-band promotion</i>: whole classes or courses, • sufficient working places for a whole class • in the frame work of school activities • direct relation to the school curriculum, formal type of learning
SchülerLabor ^F	Young people s Research Center	<ul style="list-style-type: none"> • <i>individual promotion</i>: capable and keen boys and girls • Long-term, free research and laboratory work • separate building with appropriate equipment • non-formal / informal activities beyond school, extracurricular
SchülerLabor ^L	Teaching-Learning- Laboratory	<ul style="list-style-type: none"> • part of teacher s university education (compulsory) • direct relation to the school curriculum
SchülerLabor ^W	Schülerlabor for science communication	<ul style="list-style-type: none"> • communication of the R&D activities of the owner organisation
SchülerLabor ^U	Schülerlabor with relation to entrepreneurship	<ul style="list-style-type: none"> • information about entrepreneurship and economic relationships
SchülerLabor ^B	Schülerlabor with vocational orientation	<ul style="list-style-type: none"> • focussed on offers for information about vocational possibilities

category = mode of operation: bivalence or multivalence of single laboratory

considering one schülerlabor:

One schülerlabor works
at the same time and at the same place
in two modes of operation, e.g.:

one Schülerlabor works
at different times but at the same place
or
at the same time but at different places
in two modes of operation, e.g.:

SchülerLabor^{KL}

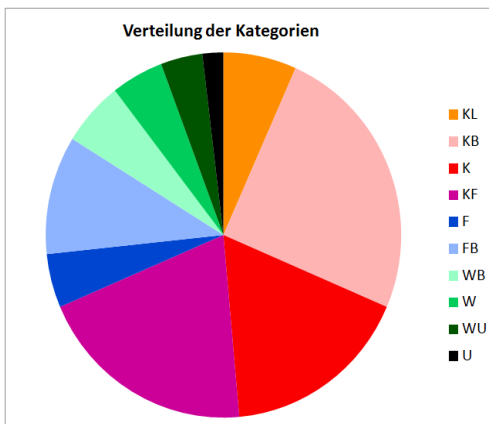
SchülerLabor^{FK}



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evaluation of available data



valid statements:

- all real schülerlabors have been covered
- K-labs most abundant category, frequently in bimodale operation

**LeLa-categorisation is important
for comparability within the
Federal Republic of Germany
(beyond the state boundaries)**

LernortLabor: reference

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- **effect to the inside:** operators of schülerlabors can better utilize synergetic effects and perhaps can establish cooperations or regional networks
- **effect to the outside:** Users, supporters and the school administration can identify the desired target group,
printed media and TV can better comprehend and describe targets and facts
- **educational sciences:** single type of schülerlabors as comparable entity yields more reasonable and evident statements

apparent heterogeneity of scene of schülerlabors collapses

categorisation can be referred (in German language) to

- as short letter-type article in: **LeLa magazin** 5 (March 2013)
- as full paper in MNU-journal:

O.J. Haupt, J. Domjahn, U. Martin, P. Skiebe-Corrette, S. Vorst, W. Zehren, R. Hempelmann, *Schülerlabor – Begriffsschärfung und Kategorisierung*, MNU 66/6 (2013) 324-330

can be down loaded from www.lernort-labor.de

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LeLamagazin

Neues aus dem Bundesverband

Ausgabe 5 • März 2013

Leitartikel

Schülerlabor – Begriffsschärfung und Kategorisierung

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Schülerlabor

Das EnergyLab im Wissenschaftspark Gelsenkirchen

Seite 8

Netzwerk

GenAU – Netzwerk der Schülerlabore in Berlin und Brandenburg

Seite 10

Klett MINT

with ISSN-Nr.

Aim of the editorial board:

- Short versions of scientific papers with relation to Schülerlabores
- Initiation of educational scientific discussions about Schülerlabor issues
- Reviews of relevant new book editions

SEMT broad-band support, whole classes:
 infrastructure adequate for the respective subjects
 pupils perform laboratory work in small groups } at least 10 working places

Essential difference to experiments in schools:

- the environment has „flair“:
 fascinating situation
 → pupils are interested,
 pay attention and work intensively.
- no 45 minute timing: pupils can also
 go along „wrong“ ways:
 there is sufficient time for corrections.
- no marks and no „performance pressure“
 misconceptions become clear.
- girls and boys: „gender gap“ very small in schülerlabors,
 only the way of working can differ.



for instance NanoBioLab:
 experimentation every Thursday (mostly 2 events, am and pm);
 number of student visits in one year : **1600**



types of experiments

single visit of a schülerlabor, content-independent of the school → „event“.

Teachers want to achieve substantially more: longer-lasting motivation of their students and content-support of their school teaching, i.e. cognitive effects.

type of laboratory work	manual	supervisors	remarks
inquiry-based experimentation	sparcely, only problem posing	intensive: laboratory responsible and 4 to 6 <i>educated</i> tutors per class	pre-knowledge from school, comparatively simple experiments
guided inquiry-based experiments	explanations, helps for learning („prompts“)	less intensive	degree of complexity of the experiments higher
recipe-type experimentation („cooking book“)	detailed instruction	down to just 1 supervisor per class	highly-complex experiments: e.g. in molecular-biologic schülerlabors

also mixed forms: highly-instructed experimental parts along with open experiments

didactical conditioning of experiments for inquiry-based experimentation

inquiry-based experimental problems → particular sustainable experimentation:

- autonomously workable/processable, with minimum intervention of tutors
- thematically connected with the actual school program (pre-knowledge necessary),
- divided into partial tasks, each resolvable in maximum 15 minutes,
- open and enactively resolvable problems,
- addresses misconceptions

repeated visits desirable



characteristics of classical schülerlabors

classical schülerlabor: close relation to school curriculum

classical schülerlabors with strong demand:

Chemistry, Biology (Life Science), Physics and Technics schülerlabors.

Less demanded: Mathematics, Informatics, Geography/Geology.

Difficult situation for: Material Science, Nanotechnology, Mechatronics, etc.:

Connection to school subjects is not always straightforward

„Owner“ in most cases: university:

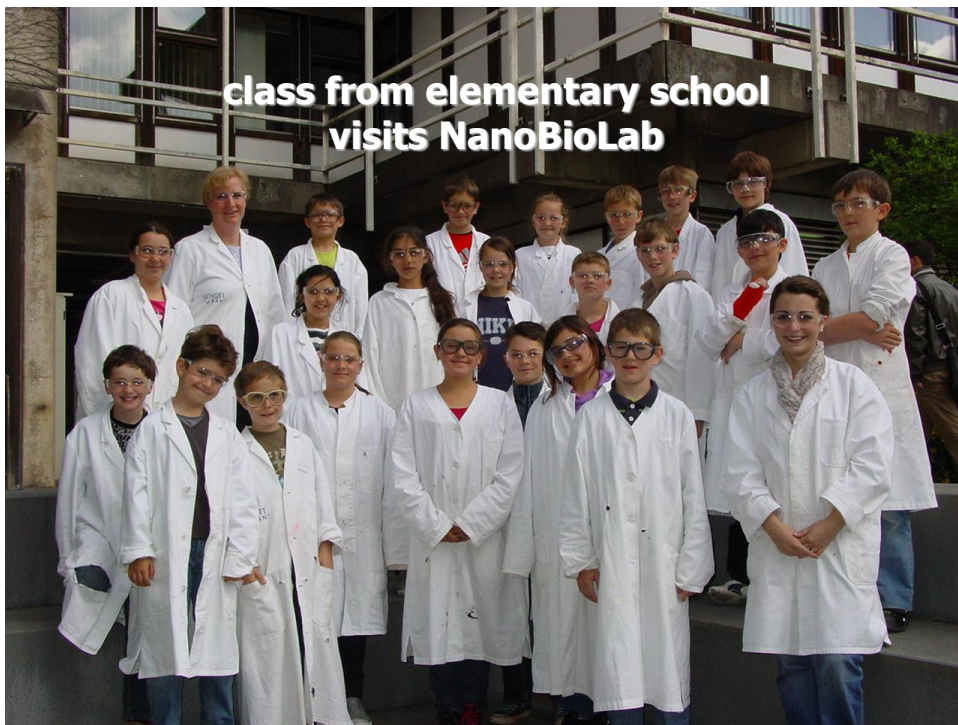
Supervision and mentoring by existing personal (academic and technical people) and by in-service school teachers part-time delegated to the university.

Classical schülerlabors of universities can advantageously be extended to Teaching-Learning-Laboratories

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Teaching-Learning-Laboratories

LeLa *magazin 7* (November 2013)



- exist only at universities with teacher students
- schülerlabor is compulsory part of university didactics education (teaching of subject-specific didactics using the respective schülerlabor as platform)
- pre-condition: university subject = school subject:
Biology, Chemistry, Physics, Geography,
to a small extent Mathematics, Informatics
- direct relation to curriculum at school

Pure Teaching-Learning-Labs ???

There are some, which however do not fulfill the criterion „20 laboratory days“
→ not registered by LeLa, data not available.

in most cases:

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2nd target group of schülerlabors: teacher students



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benefit for teacher students

1st course: practical chemistry-specific educational training in the laboratory room of the schülerlabor without pupils (with school-type equipment),

2nd course: inquiry-based learning and experimentation with pupils

compulsory tutorials in SaarLab-Labs: 6 NanoBioLab, 3 others



- pre-school training of teacher students close to the school reality
- engaged and well-educated tutors for the kids in the Schülerlabor

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3rd target group: in-service teachers

just during the visit in the schülerlabor:

- new technologies
- new experimental techniques and methods
- contact to university



additionally most schülerlabors offer
training of in-service teachers



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4th target group: Junior Students

80 Junior Students at Saarland University per year,
20 of which with subject Chemistry (future elite students)



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win-win-situation, utilisation of synergies;

advantages for the head of a university schülerlabor:

- implementation into the key mission „teaching“
→ long-term existence of schülerlabor is secured
- practical work in subject-specific didactics:
→ many well-educated and very engaged tutors

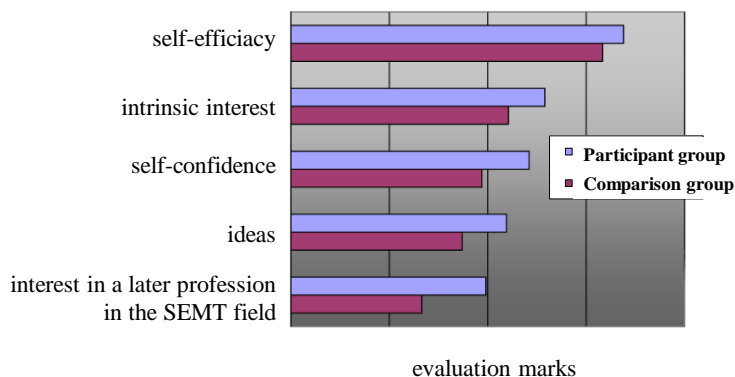
Increasingly important: **empirical instructional research**

- implementation into the key mission „research“ of the university
→ schülerlabors constitute ideal research platforms
- many master theses on schülerlabor problems:
→ very well-educated collaborators in the group of tutors
- from time to time a doctoral thesis, financed by third-party money
→ thesis student helps with the coordination of the schülerlabor
- publications increase visibility

implementation into research

kids as active „researchers“: for instance Chemistry

kids as „object“ of research: Chemistry-related didactics, instructional studies



Walter Zehren,
*Inquiry-based
Experimentation
in Schülerlabors,*
Thesis,
Saarbrücken 2009

Recently: Dr. phil. nat. in addition to Dr. phil., Dr. rer.nat., Dr. ing.

Walter Zehren, Heinz Neber und Rolf Hempelmann, *Kognitive und motivationale Effekte durch regelmäßiges Forschendes Experimentieren im Schülerlabor*, MNU-Zeitschrift 66/7 (2013) in print



schülerlabors as bridge between scientists in specific subjects and in subject-specific didactics



„Marketing“- advantages for the university:

- assistance and advice for pupils with respect to later choice of a study subject
- inspiration for a study in the field of SEMT
- increase of number of beginner students and of their „quality“
- decrease of number of those students who give up (drop-out fraction)

„Management“ advantages for the university through implementation of their *university* schülerlabors into teaching and research:

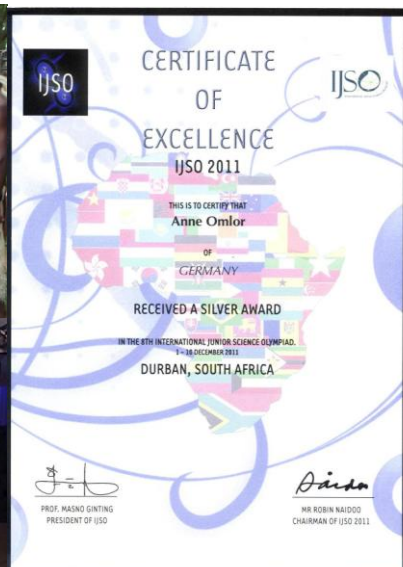
- in the faculties schülerlabors bridge the different attitudes of the professors working in subject-specific didactics/education and those working in natural and engineering sciences
- among the teacher students schülerlabors act as bridge between different types of schools,
- Schülerlabors, from time to time, „produce“ extremely good students

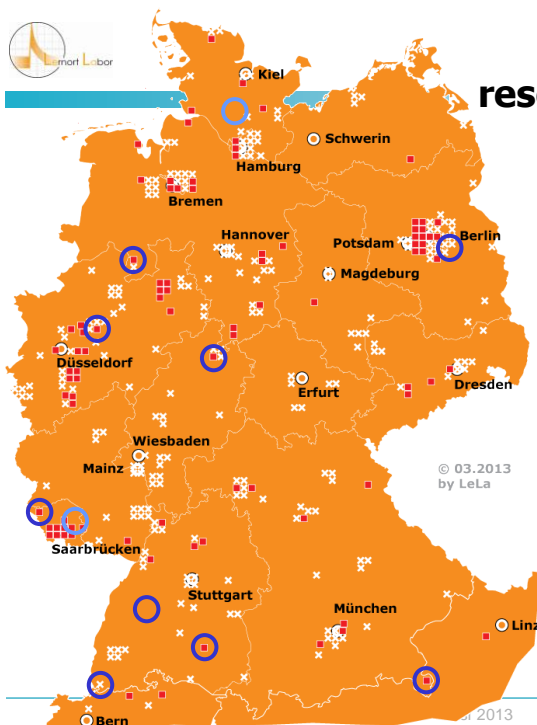


Anne Omlor, 13 years old



Gold medal and trophy
European Science Olympiade
(EUSO) Luxembourg 2013





young people's research centers (YPRC) in Germany



100 member labs, among them
10 YPRCs

○ existent, ○ under construction



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young people's research center (YPRC)



offers as supplementary facility (besides schools and other schülerlabors):

- support of individuals / leisure-time pursuit in the field of SEMT
- well-equipped laboratories
- experienced supervisors/mentors for young peoples' research
- contacts to companies, research institutes and universities,

Low-threshold regional offer, addresses **interested** young people,
in full intention also future non-academic professionals

„side effects“ (colateral benefits): development of essential soft skills

- discoverer pleasure
- one's own initiative, standing
- ability to work in teams
- ability to accept critics & compromises
- ability to communicate
- ability to work with new media



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-
- courses (6 to max. 12 participants), e.g., brazing course
- inventor club
- **puzzling, developing and „research“** (informal learning)
- students' industrial projects in offer/order relationship
- summer schools (non-formal learning)
- evening events for the interested public
- students' conference

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- operation as classical schülerlabor (formal learning)
- courses (6 to max. 12 participants), e.g., brazing course
- inventor club
- **puzzling, developing and „research“**
- students' projects in offer / order relationship
- vacation courses
- evening events for the interested public
- students' conference

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Schülerlabors at Uds:

2002
foundation of
Center of Nanoanalytics (CFN)
of Physics

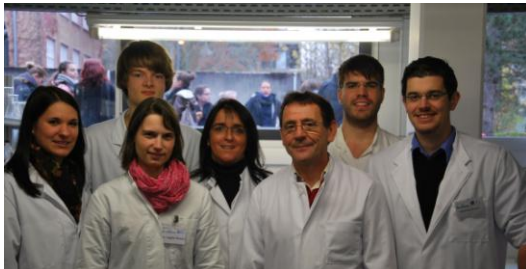
2002
foundation of
Mach-mit-Labor
of Biochemistry





NanoBioLab

official opening January 2003





Secondary stage II

Schülerlabor SinnTec

Technical sensing devices

Focus on
mechatronics
and sensor technology



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Offers for

- Groups of pupils of all ages (Primary school up to Gymnasium)
- Practicals for pupils
- Individual projects
- Training of in-service teachers
- Education of pre-service teachers

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Individual promotion



Universal platform for
experiments in electronics
for Schools, school groups and pupils



- Demo experiments
- Learning by doing
 - electronics
 - programming
 - calibration
- Base for realisation of own projects

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Seven-Labs-Tour – a Science Camp in the autumn school vacations



SaarLab 23.04.2006



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Robert Bosch **Stiftung**

Achtung, fertig, forschen!
Der Preis »Schule trifft Wissenschaft« 2009
der Robert Bosch Stiftung

Die Robert Bosch Stiftung verleiht einen der Preise »Schule trifft
Wissenschaft« 2009 an das Projekt

SaxLab und die Sicher-Labore-Tour

initiiert von

Universität des Saarlandes

Der Preis »Schule trifft Wissenschaft« wird 2009 zum ersten Mal vergeben. Er ist eine Auszeichnung für die gemeinsame Arbeit von Lehrern und Wissenschaftlern, die mit großem Engagement und innovativen Ideen neue Wege gehen, um Schüler für Naturwissenschaften und Technik zu begeistern. Wir prämiieren mit diesem Preis beispielhafte Kooperationsprojekte, die das Wissen der Forscher, die Expertise der Lehrer und die Neugier der Schüler zu einer neuen Form des Lernens und Lehrens verbinden. Der Preis »Schule trifft Wissenschaft« ist mit einem Hauptpreis von 50.000 € und zwei weiteren Preisen von je 20.000 € dotiert.

Berlin, 19. Mai 2009

Angelika Ramm
Dr. Angelika Ramm
Robert Bosch Stiftung



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UniCamp
Study center of Uds






first participation
23.07.2004



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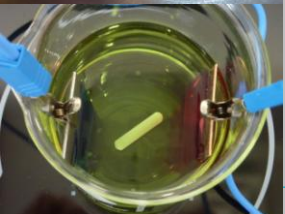
 coating with zink
in lab and industry

$$\frac{1}{2}O_2 + H_2O + 2e^- \rightarrow 2OH^-$$

$$Fe \rightarrow Fe^{2+} + 2e^-$$

$$\frac{1}{2}O_2 + Fe + H_2O \rightarrow Fe^{2+} + 2OH^-$$

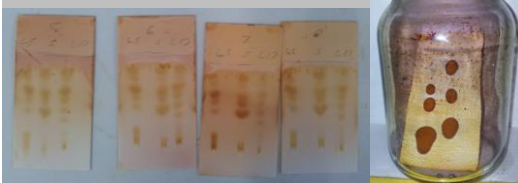
$$Fe^{2+} + K_3[Fe(CN)_6] \rightarrow K[Fe^III Fe^II(CN)_6] \cdot 6H_2O + 2K^+$$





Lab and industry (KD Pharma in Bexbach): omega-3 fatty acids



ethyl esters of fatty acids



Thin layer chromatography



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Haus der Kleinen Forscher Kindergarten



**SaarLab: complete out-of-school SEMT educational chain,
connectivity of the offers**



Schülerlabor in Primary School

NaSci in Schülerlabor
Secondary stage 1



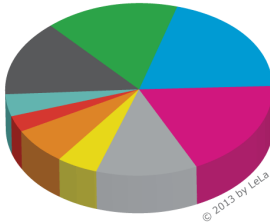
SEMT in Schülerlabor
Secondary stage 2



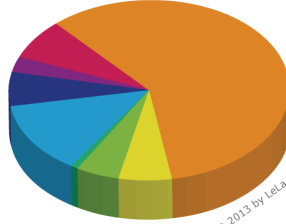
Junior study



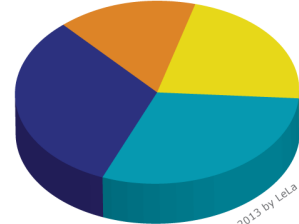
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- Biologie
- Chemie
- Physik
- Technik
- Mathematik
- Informatik
- Medizin
- Geowissenschaften
- Multidisziplinär



- Universitäten & Forschungseinrichtungen
- Museen & Science Center
- Industrie
- Technologie- & Gründerzentren
- Vereine & private Initiativen
- Gemeinnützige Bildungseinrichtungen
- Schulen
- Sonstige



- Klassen 1 bis 4
- Klassen 5 bis 7
- Klassen 8 bis 10
- Klassen 11 bis 13

